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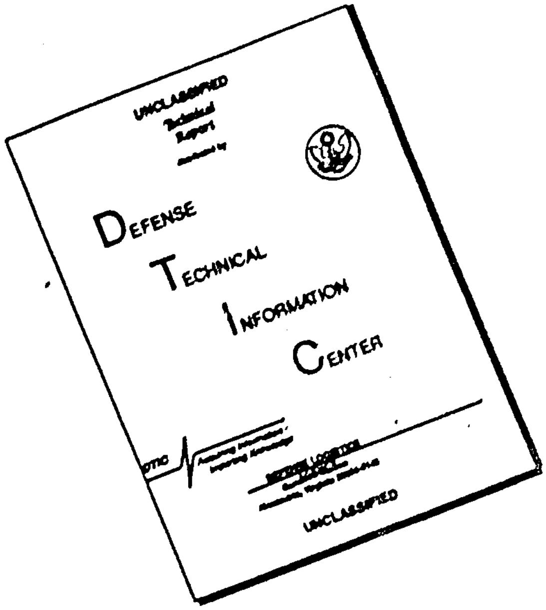

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NAVORD REPORT 4376

A COMPARATIVE STUDY OF THE STATIC SPARK SENSITIVITY OF SEVERAL FORMS OF BASIC LEAD STYPHNATE AND PRIMING MIXTURES CONTAINING ZIRCONIUM METAL AND ZIRCONIUM HYDRIDE

FC

6 AUGUST 1956

U. S. NAVAL ORDNANCE LABORATORY

WHITE OAK, MARYLAND

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A COMPARATIVE STUDY OF THE STATIC SPARK SENSITIVITY OF SEVERAL FORMS OF BASIC LEAD STYPHNATE AND PRIMING MIXTURES CONTAINING ZIRCONIUM METAL AND ZIRCONIUM HYDRIDE

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ABSTRACT: Associated with the loading of primer mixes containing basic lead styphnate are problems involving flow, dusting and static spark sensitivity. In an effort to minimize the effects of the poor flow and the high degree of dusting, the Laboratory, following British procedures, prepared several different polymorphic forms of basic lead styphnate which were larger in particle size than U. S. commercial basic lead styphnate. One of these forms was purported to be less static spark sensitive by the British. This report is concerned with the static spark sensitivity testing of these new forms of basic lead styphnate as compared to the commercial basic lead styphnate now in use. Also tested at this time because of their wide current interest were milled normal lead styphnate and priming mixtures containing zirconium metal and zirconium hydride. In all cases except that of the zirconium hydride primer mix, the material tested was more static spark sensitive than the commercial basic lead styphnate.

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This report outlines the results of a study made to compare the static spark sensitivity of several new forms of basic lead styphnate to that of commercial basic lead styphnate now in use. The results of this investigation are intended for the information and use of the Naval Ordnance Laboratory and should be of interest to other activities using basic lead styphnate. This work was performed under task NOL-B2b-41-1-56.

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Captain, USN
Commander

R. C. DANIEL
By direction

Acknowledgment

The author wishes to acknowledge the assistance of Mr. W. D. Schutt for his instruction in the use of the Explosive Electrostatic Sensitivity Tester.

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INTRODUCTION

1. Priming mixtures containing basic lead styphnate such as NOL #130 primer mix and NOL #60 primer mix are currently being used in Navy primers and detonators. Problems in handling and loading of these mixes have arisen which are due mainly to the basic lead styphnate in the priming mixes. The most obvious problems in loading these mixes are the poor flow properties, the high degree of dusting, and the static spark sensitivity. One approach at improving these conditions is wet loading. At the present time an investigation of the feasibility of this method for loading percussion primers is being studied. The only practical method, which is still widely used, for cover charge loading in detonators and stab primers is dry loading.

2. Another approach to improving the flow and dusting properties was to obtain a freer flowing, non-dusting basic lead styphnate. The British did some work in this direction and met with favorable results. By the addition of crystal habit-controlling agents the British succeeded in obtaining new polymorphic forms of basic lead styphnate which were also larger in particle size, free flowing and non-dusting. These methods were passed on to the Laboratory and experimental batches of these polymorphic forms of basic lead styphnate were prepared. Actually three different crystalline forms of basic lead styphnate were prepared. They are identified as RD 1346 Preparation #4, the crystals of which under a microscope appeared as clusters with many needle-like points protruding from spherical surfaces; RD 1346 Preparation #5, the crystals of which appeared as rounded particles; and RD 1349, the crystals of which appeared cigar-shaped. By comparison the standard commercial basic lead styphnate now in use is smaller in particle size consisting of flat plate-like crystals.

3. In evaluating these new crystalline forms of basic lead styphnate they will be compared to the standard basic lead styphnate as to dusting, flow properties, sensitivity, output, stability, and static spark sensitivity. This report is concerned specifically with the static spark sensitivity of these new crystalline forms of basic lead styphnate as compared to the standard basic lead styphnate now in use. Also tested for static spark sensitivity at this time was milled normal lead styphnate, a primary used fairly extensively in production items. Due to their wide current interest two priming mixes, containing zirconium and zirconium hydride, which are used in the Mk 10 delay element and the NOL's 808A experimental delay element respectively, were also tested for static spark sensitivity.

4. The purpose of this study was to determine the relative danger (static spark-wise) of specific materials as compared to materials now in use. The data obtained will give an indication of what might be expected of the materials studied if they are elected to be used and is not intended to be a definitive study in the static spark sensitivity field.

Test Procedure

5. The instrument used for testing is a modified version of the Explosive Electrostatic Sensitivity Tester as reported in NOLM 9959. See Figure 1 for schematic. The explosive sample holder is a modified plastic firing pin and detonator holder cemented to a steel electrode as in Figure 2. For all materials tested the charge weight was twenty milligrams.

6. The movable electrode on the test instrument was so adjusted that when completely depressed it was just above the surface of the explosive under test. Ten samples were tested at each energy level from the all-fail point (when possible) to all-fire point (when possible). Although ten trials per energy level are relatively small it was felt that this sampling would be adequate to establish the information desired. For data purposes only one attempt to fire each individual sample was made. If it failed to fire, the sample was destroyed by subjecting it to a much higher energy spark.

7. In obtaining the static spark sensitivity data two procedures were used; one consisted of keeping the voltage constant and varying the capacitance, the other keeping the capacitance constant and varying the voltage. The energy was calculated using the equation $E = 5CV^2$, where:

E = energy in ergs
C = capacitance in micromicrofarads
V = potential in kilovolts

Summary of Results and Discussion

8. The results in Table 1 were obtained by keeping the capacitance constant at 50 micromicrofarads and varying the voltage. Figure 3 is a plot of these data as percent fires versus energy. The results in Table 2 were obtained by keeping the voltage constant and varying the capacitance. Figures 4 and 5 are plots of these data as percent fires versus energy.

9. The British data concerning RD 1349 indicated that this particular crystalline structure was nonstatic spark sensitive. The NOL test results for this preparation are to the contrary. It is possible that in the preparation of this crystalline form of basic lead styphnate we did not obtain the identical material the British did or that our test instrumentation and procedure are sufficiently different from that of the British that comparable results are not obtained.

10. At the end of a test run of applying a static spark to the explosive materials, some had always failed to initiate. Attempts were made to destroy these failures by firing at energies above the materials indicated all fire energy. In attempting to destroy those samples of standard basic lead styphnate which had failed at the lower energy levels, it was found necessary to raise the energy level much higher than the predicted all-fire point. In some cases the sample failed to initiate within the limits of the instrument or merely burned. The standard basic lead styphnate became less sensitive to static spark once it failed to initiate at a given energy level. This phenomenon was observed only for standard basic lead styphnate.

11. The relative humidity of the testing room ranged from 20 per cent to 50 per cent. However, there was no apparent correlation between the relative humidity and test results.

12. At voltages of 1 KV or less there was no visible spark observed between the electrodes when the sample failed to initiate. In some instances when a sample failed to initiate, the material was found adhering to the needle.

CONCLUSIONS AND SUMMARY

13. Both the new experimental basic lead styphnates and the milled normal lead styphnate appear to be more static spark sensitive than the standard basic lead styphnate when tested on the NOL Static Sensitivity Test Device.

14. The experimental basic lead styphnates are comparable, static spark-wise, to milled normal lead styphnate, which is being used safely in production. If these new styphnates meet output, stability, and sensitivity requirements, it is the author's opinion that they would not be objectionable because of their increased static spark sensitivity.

15. The comparison of the two primer mixes definitely shows the zirconium metal mix to be much more static spark sensitive than the zirconium hydride primer mix.

APPENDIX A

Composition of Primer Mixes

<u>808A Primer Mix</u>

28.5% Zirconium Hydride
66.5% Lead Peroxide
5.0% Tetracene

<u>Mk 10-0 Primer Mix</u>

26.2% Zirconium Metal (powder)
70.8% Lead Peroxide
3.0% Tetracene

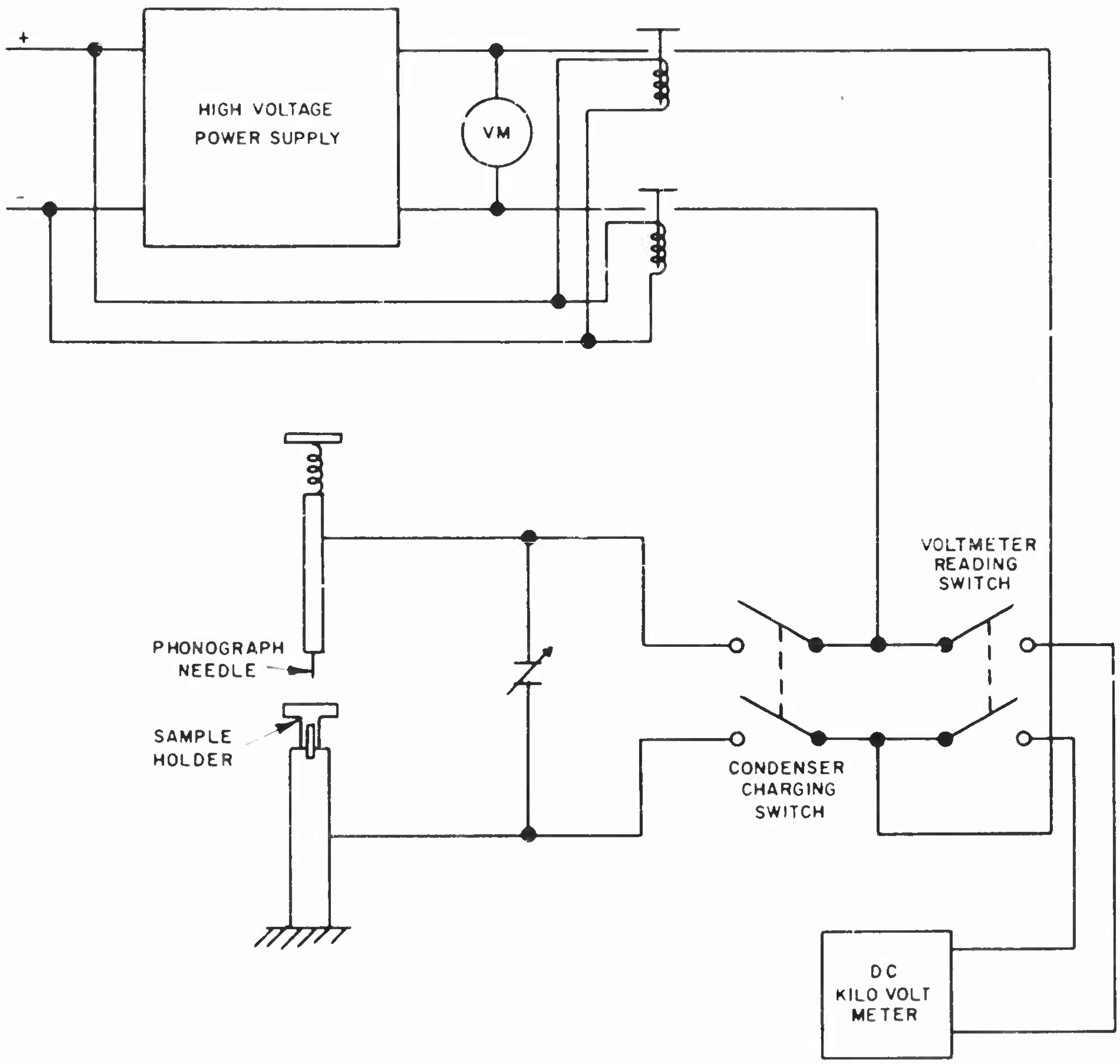

FIG. 1 STATIC SPARK GENERATOR

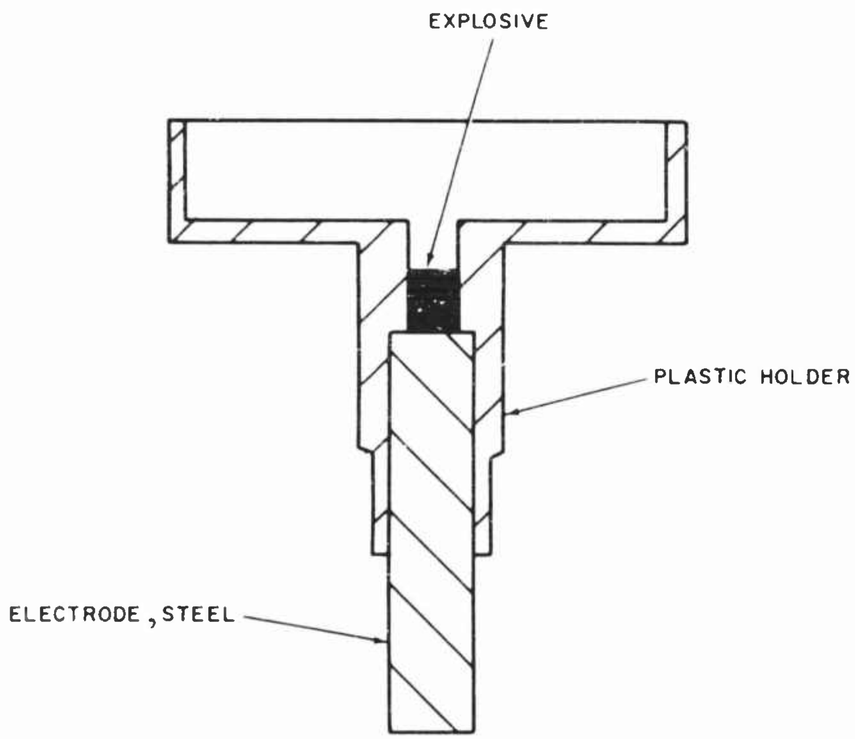

FIG. 2 EXPLOSIVE SAMPLE HOLDER

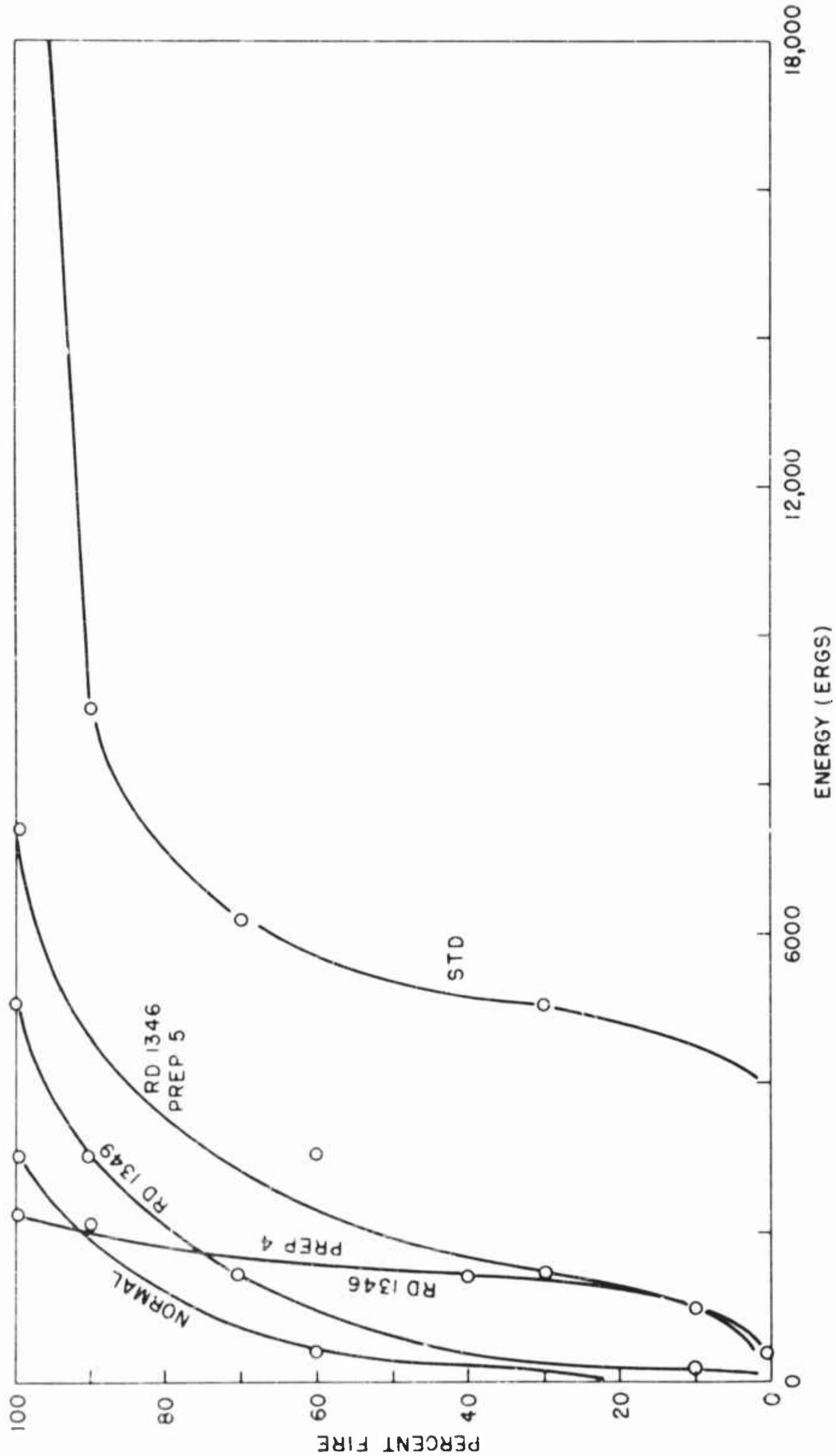

FIG. 3 BASIC LEAD STYPHNATE SAMPLES
PERCENT FIRE VS ENERGY

CONSTANT CAPACITANCE AT 50 MICRO MICRO FARADS

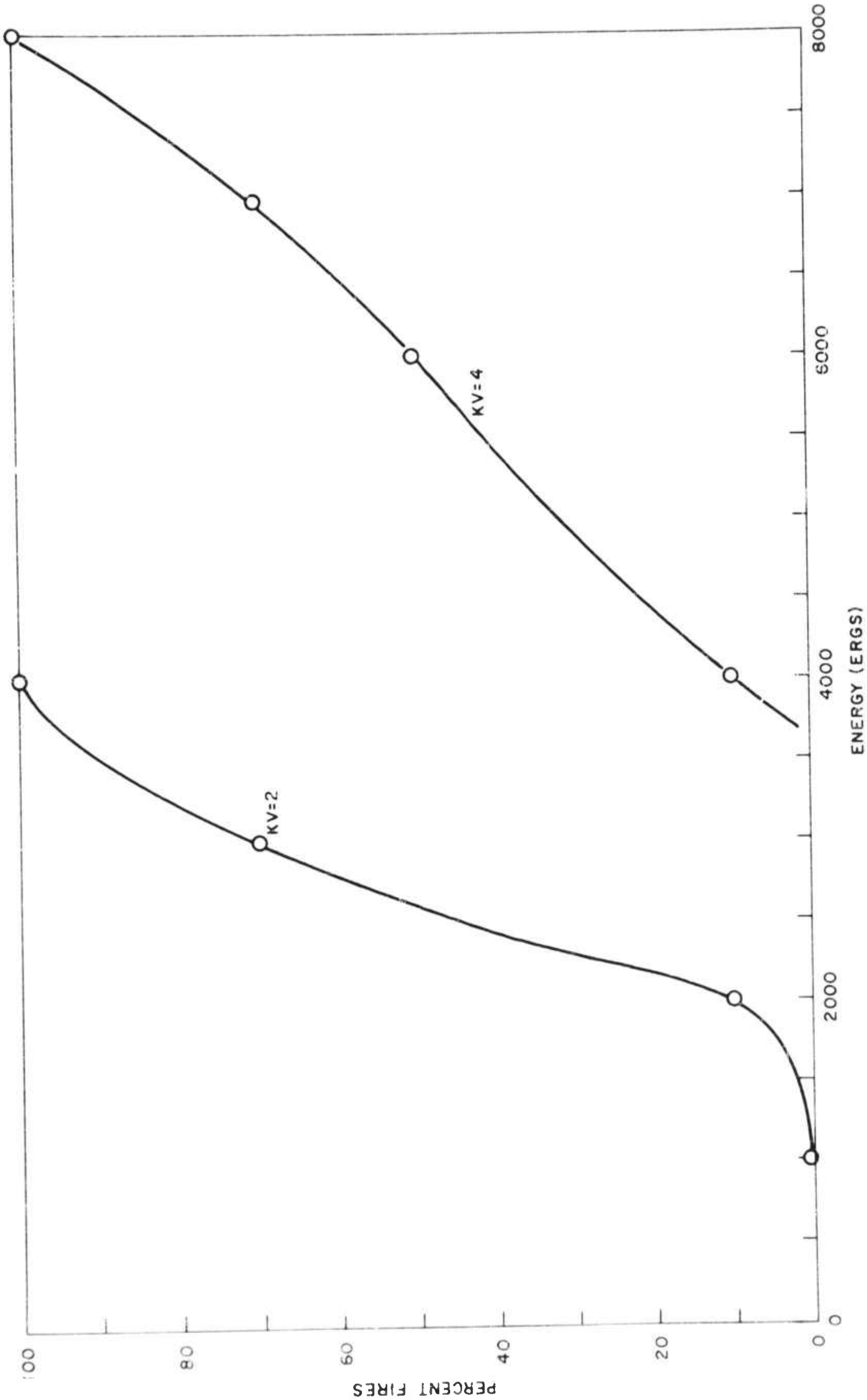

FIG. 4 STANDARD BASIC LEAD STYPHNATE, CONSTANT POTENTIAL AT 2 AND 4 KV

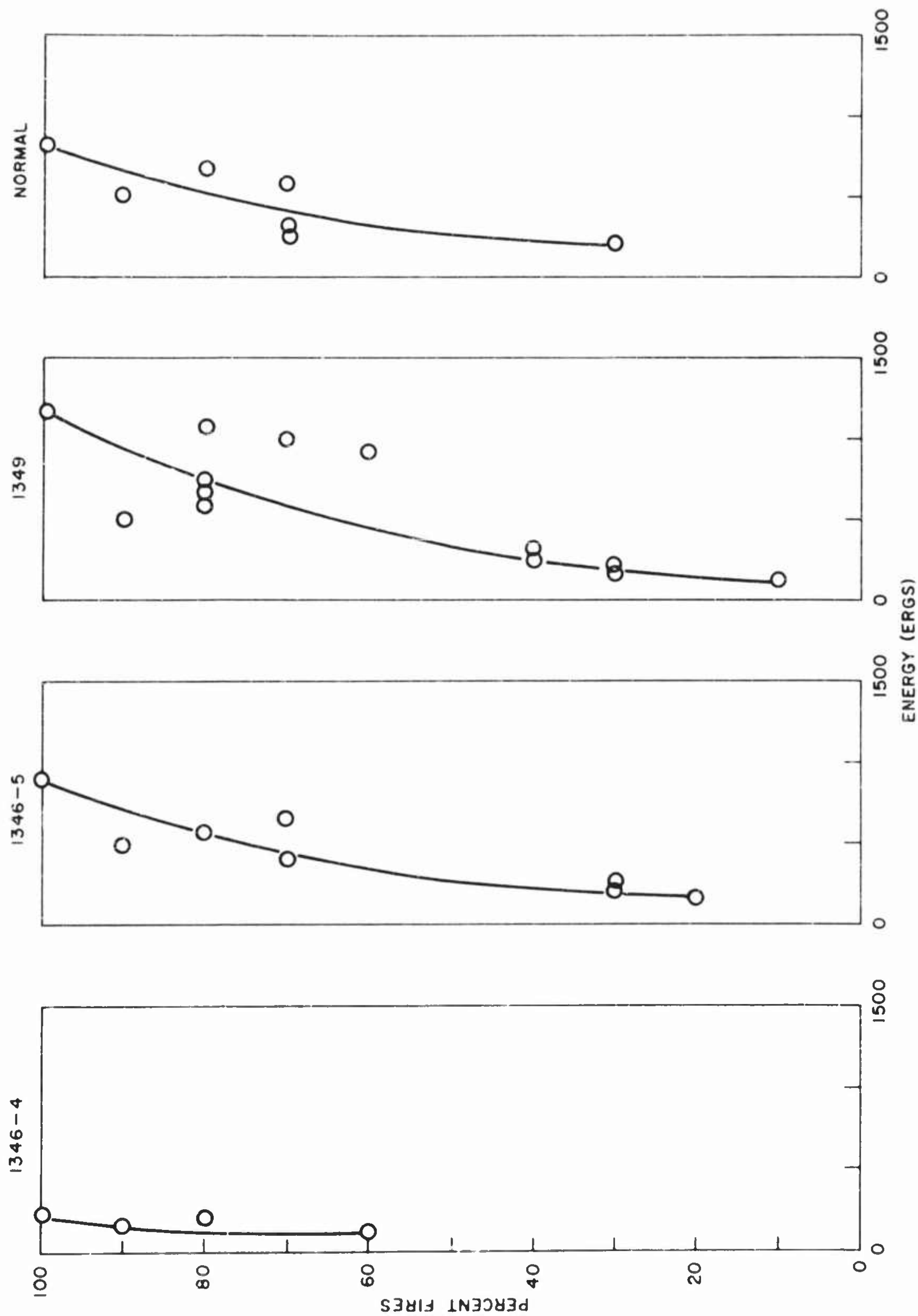

FIG. 5 CONSTANT POTENTIAL AT 1 KV
LEAD STYPHNATE SAMPLES

[illegible]	1 [illegible]	1	1.	2	2.	3	3.	4	4.		.		.	[illegible]	7.		8.	9	9.5	10	10.	11	20	[illegible]
[illegible]	5		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.
Standard [illegible]									[illegible]	7	[illegible]	[illegible]	7[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	9[illegible]	9[illegible]	9[illegible]	1[illegible]		
[illegible] 13[illegible]			[illegible]	3	[illegible]	[illegible]	[illegible]																	
[illegible] FIS [illegible] 13- [illegible]	[illegible]	2	30	10	30	3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100													
[illegible] B[illegible] 13[illegible]	[illegible]	1[illegible]	3[illegible]	[illegible]	7[illegible]	[illegible]	[illegible]	[illegible]	100															
[illegible]al Lead [illegible] Milled	[illegible]0	7[illegible]	[illegible]	70	7[illegible]	9[illegible]	100																	
[illegible] Primer Mix				[illegible]				[illegible]												[illegible]			0	0
MK 10-[illegible] Primer Mix	40	7[illegible]	9[illegible]	100																				

TABLE I

Percent Initiation at a Given Energy Level
Constant Capacitance at [illegible] Micromicrofarads
Sample Size = 1[illegible]

Capacitance Micromicro-farads	30	40	50	60	80	100	120	140	160	180	200	220	240
ERGS	150	200	250	300	400	500	600	700	800	900	1,000	1,100	1,200
EXP. BLS RD 1346 PREP 4	60	90	80	100									
EXP. BLS RD 1346 PREP 5	0	20	30	30	70	90	80	70	80	100			
EXP. BLS RD 1349	10	30	30	40	40	90	80	80	80	60	70	80	100
Milled Normal Lead Styphnate	0	0	30	70	70	90	70	80	100				
Mk 10-0 Primer Mix	40	40	50	40	50	80	80	80	70	80	100		

Constant Voltage at 2 KV

Capacitance Micromicro-farads	50	100	150	200									
ERGS	1,000	2,000	3,000	4,000									
STD. BLS	0	10	70	100									

Constant Voltage at 4 KV

Capacitance Micromicro-farads	50	75	87	100									
ERGS	4,000	6,000	6,960	8,000									
STD. BLS	10	50	70	100									

Constant Voltage at 10 KV

Capacitance Micromicro-farads	350	400	440	470									
ERGS	175,000	200,000	220,000	235,000									
303 A Primer Mix	0	40	40	50									

TABLE 2

Percent Initiation at a Given Energy Level
Constant Voltage at 1 KV
Sample Size = 10

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